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(54) Title of the invention

Plasma processing method

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Detailed sheet

1. Title of the invention

Plasma processing method

2. Scope of the patent claim

The plasma processing method which is the method where plasma gas is introduced by multiple feed ports, and by means of flowing down within the plasma gas processing chamber towards multiple vents that correspond to each of these feed ports, which carries out plasma processing to the substrate within the above- mentioned plasma processing chamber,

And which has the characteristic feature that the flow amount of plasma gas is adjusted in such a way that the amount of plasma gas that processes partially the substrate surface which has a large surface along the flow direction of the plasma

gas amongst the processing surfaces of the above- mentioned substrate, is larger than the amount of plasma gas that processes the other substrate surface parts.

3. Detailed explanation of the invention

{ Fields of use in the industry }

The said invention is concerned with the plasma processing method, in particular the plasma processing method that carries out the homogenization of the processing with regard to the substrate in particular.

[Conventional technology]

The olefin based resins such as PP (Poly propylene), PE (poly ethylene) etc, from the fact that they are comparatively superior in weather resistance property, mechanical strength, molding property, etc, and it is extremely cheap price-wise also, has the trend of being increasingly used not only in daily commodities but even in components for use in automobiles.

Conversely, the olefin based resins due to their nature of being highly crystalline, non - polar, is poor in surface activity and at the time of secondary processing such as coating, printing, adhesion etc, and the adhesive property cannot be obtained, and becomes a bottle - neck. As a measure to confer activity to these, frame processing, ultra - violet ray irradiation processing, corona discharge treatment, plasma processes which make use of radio waves, micro waves etc can be considered.

In the automobile material, from the above - mentioned solid state properties, balancing of cost, the use of poly propylene in particular has increased, and in particular, the use of conventional steel, urethane, etc in bumpers has risen. However, from the aspects of the variety of design, the improvement of the aerodynamic function, the bumper also has come to be considered as one part of the body panel, and the color also is mostly coated with the same color as the body color from the conventional resin color (mostly black).

At this juncture, when the coat is (illegible) in the bumper, although one part uses the above- mentioned reforming method, until the body color coating is administered in the greater part, the current situation is that the primer coating of olefin chloride etc is coated in advance. When the primer coating process is done on a large - scale component such as the bumper, it requires a large area in the coating booth, drying furnace, and the (illegible) of steam, electricity, etc is (illegible) and further from the fact that organic solvents are largely used, it is not preferable from the aspect of the work environment. At this juncture, the plasma processing method amongst the above- mentioned reforming methods is studied for its' application from the aspect that there is processing stability for the molded products of large size.

[Issues that the invention tries to resolve]

However, even with this plasma processing method, the homogeneous contact of the above- mentioned molded product with the gas that is induced such as oxygen, nitrogen etc which contributes to the surface reforming, is difficult, and the processing of the corner parts etc where it is difficult to come into contact with the plasma gas becomes easily insufficient, and becomes the reason also for the coat peeling etc. Here, currently countermeasures such as rendering the processing time long etc has been put into place but the cycle time gets extended, and is not

preferable for production. In particular, when it is placed in the line etc, the balance with other processes is not present, and becomes a large issue.

The said invention is that which has considered the above circumstances, and attempts to present a plasma processing method that can carry out the homogenization of the processing with regard to the substrate.

[Procedure in order to resolve the issues]

The plasma processing method of the said invention, is that which carries out the homogenization of processing by means of adjusting the flow amount of the plasma gas within the plasma processing chamber. In other words, it is the plasma processing method which is the method where plasma gas is introduced by multiple feed ports, and by means of flowing down within the plasma gas processing chamber towards multiple vents that correspond to each of these feed ports, which carries out plasma processing to the substrate within the above-mentioned plasma processing chamber, and which has the characteristic feature that the flow amount of plasma gas is adjusted in such a way that the amount of plasma gas that processes partially the substrate surface which has a large surface along the flow direction of the plasma gas amongst the processing surfaces of the above - mentioned substrate, is larger than the amount of plasma gas that processes the other substrate surface parts.

(Action)

By means of the above - mentioned structure, the processing gas amount per unit area in each part of the substrate surface is homogenized, and a homogeneous plasma processing can be carried out in the entire substrate surface.

[Result of the invention]

Therefore, by means of the said invention, even if the substrate has a complex substrate surface shape, it is possible to carry out a homogeneous plasma processing, and since the processing time is shortened, the cycle time can be made shorter, and it is possible for the synchronization with other processes and the formation of line becomes easy. Further, when the coating process is carried out in the post - process, it becomes possible to form a homogeneous coat layer.

(Practical examples)

Below is explained in detail about the practical example of the said invention with reference to the attached figure.

Figure 1 is the sectional side view that shows the plasma processing device that is used in the plasma processing method of the said practical example.

Plasma processing chamber 1 is made up from a cylindrical chamber 2 and entry side door 3 and the exit side door 4 that are set up on both terminals adjustable for opening and closing, and within the plasma processing chamber 1, the substrate work 5 is placed over the net conveyor 6. In the upper terminal part of the cylindrical chamber 2, 3 groups of plasma generation furnace 7 are positioned such that they are placed in the required interval, along the longitudinal direction. Each plasma generation furnace 7, is composed of a feed port shower tube 8 that feeds plasma gas within the plasma processing chamber 1, a three stub tuner 9 and an electro magnetic wave oscillation device 10, and the gas such as oxygen etc which is supplied via the feed- side flow amount adjustment valve 12 from the

processing gas supply source 11, is formed as plasma, and is made such that it is introduced from the shower tube 8 to the plasma processing chamber 1.

In the lower terminal part of the cylindrical chamber 2, exhaust ports 13 are formed in 3 places that manage each shower tube 8 of the above-mentioned plasma generation furnace 7. These exhaust vents 13, are connected to the mechanical booster pump 15 and the rotary pump 16 via the respective exhaust side flow amount adjustment valves 14, and in the mechanical booster pump 15, the by-pass flow path where the by-pass valve 17 is in between, is also set up.

When plasma processing is implemented in work 5, the pressure is reduced up to about 0.5 Torr within the plasma processing chamber 1, and until it becomes about 20 Torr, the by-pass valve 17 is left open and the exhaust is carried out only by means of the rotary pump 16, and the reduction of pressure more than that, can be carried out by means of these mutually, when the by-pass valve 17 is closed, and the mechanical booster pump 15 and the rotary pump 16 are directly linked.

In order to maintain the air density within the plasma processing chamber 1 at this time, silicon rubber seal 18 is placed respectively in between the cylindrical chamber 2 and the entry side door 3 and the output side door 4.

When the pressure is reduced up to the required degree of vacuum within the plasma processing chamber 1, the plasma gas that is produced in each plasma generation furnace 7 is fed into the plasma chamber 1 from each shower tube 8, and flows within the plasma chamber 1 towards each vent 13, and at that time, the plasma processing with respect to work 5 is carried out. At this time, the plasma gas that is fed from each shower tube 8, is discharged from each vent 13, flowing respectively in the direction where the flow is easier.

Accordingly when the substrate is the work 5 that has a bumper shape as is shown in Figure 1, amongst the substrate surfaces of work 5, the substrate surface part that has the surface which is orthogonal with respect to the plasma gas flow direction from the shower tube 8 to the vent 13 as in the upper surface part 5a, can be easily plasma processed and the processing time is short, whereas, as in the side surface part 5b on the right and left, it is difficult for plasma processing to be carried out in a short time period in the substrate surface parts that has large surfaces along the flow direction of the plasma gas. For this purpose, in order to carry out the plasma processing in the entire substrate surface of work 5, a long time period is required.

At this juncture, the plasma processing method of the practical example of the said invention, is that which attempts to adjust the flow amount dispersion of the plasma gas within the plasma processing chamber 1, according to the shape of the substrate. Specifically, by means of adjusting the degree of opening of the throttle valve in between 3 groups of the exhaust side flow amount adjustment valve 14 mutually or in between 3 groups of the feed side flow amount adjustment valve 12 mutually, the plasma gas feed amount from each shower tube 8 or the plasma gas discharge amount from each vent 13 is adjusted, and by means of this, the adjustment of the flow amount dispersion of the plasma gas within the plasma processing chamber 1 can be carried out. For example, with respect to the work 5

of shape as is shown in the Figure 1, amongst the 3 groups of the feed- side flow amount adjustment valve 12, by means of the degree of opening of the throttle valve of the central adjustment valve 12 taken to be half- open, and the degree of opening of the throttle valve of both the right and left side adjustment valve 12 is taken to be fully open, amongst the substrate surfaces of the work 5, the plasma gas amount that is processed on the left and right side surface parts that contain many surfaces along the flow direction of the plasma gas is relatively large, and by means of this, the homogenization of the plasma processing in the parts of the substrate surface can be attempted. Even in the case of carrying out the flow amount adjustment by means of the 3 groups of exhaust side flow amount adjustment valve 14, similarly, the degree of opening of the throttle valve of the central adjustment valve 14 is taken to be half- open, and the degree of opening of the throttle valve of both the right and left side adjustment valve 14 is taken to be fully open. The flow amount adjustment can also be carried out by means of both the feed side flow amount adjustment valve 12 and the exhaust side flow amount adjustment valve 14. Further, even when the substrate has the bumper shape also, the length of the side surface part is short, and if it does not have many surfaces along the flow direction of the plasma gas as in the side surface part 5b of the work 5, the degree of opening of the throttle valves of each feed side flow amount adjustment valve 12 and each exhaust side flow amount adjustment valve 14 can be taken to be the same.

Figure 2 is the figure showing the control mechanism the adjust the degree of opening of the throttle valve of the 3 groups of the feed- side flow amount adjustment valve 12, in order for the homogenization of the plasma processing with respect to work 5.

Work 5, is transferred to the conveyor 20 via the net conveyor 6 from the conveyor 19, and in the state where the net conveyor 6 is placed, the above-mentioned plasma processing is carried out, and the station before processing, in other words, in the state of being placed on the conveyor 19 by means of the work state recognition step (CCD) 21, the shape of the substrate surface of work 5 can be recognized before hand. Based on the output signal from this work state recognition step 21, the adjustment of the degree of opening of the throttle valve of each feed- side flow amount adjustment valve 12 by means of CPU 22 can be carried out. In other words, the output signal in order to carry out the flow amount adjustment of the plasma gas according to the shape of the parts of the substrate surface of work 5, is entered via each turbo pump 24 from CPU 22 to each turbo-motor which changes the degree of opening of the throttle valve of each feed side flow amount adjustment valve 12, and the feedback control is carried out by means of each angle detection device 25, and each turbo motor 23, can be driven up to the required degree of opening of the throttle valve of the respective corresponding feed- side flow amount adjustment valve 12.

By means of setting up the control mechanism as mentioned above, the automation of plasma processing, line formation becomes possible, and further it becomes possible to process various types of work in the same line, and the synchronization with other processes becomes also easy.

Figure 3 is where the above - mentioned control mechanism is set up with respect to the exhaust side flow amount adjustment valve 14, and its' action, result is the same as the control mechanism of Figure 2.

4. Brief explanation of the figures

Figure 1 is the side section figure that shows an example of the plasma processing device that is used in the plasma processing method of the said invention. Figure 2 and Figure 3 are the figures that show the flow amount control mechanism in order to carry out the adjustment of the flow amount of plasma gas in the mentioned plasma processing method.

- | | |
|---|-------------------|
| 1... plasma processing chamber | 5.... Work |
| 7... plasma emergence furnace | 8.... Shower tube |
| 12... feed side flow amount adjustment valve | |
| 13... exhaust port | |
| 14... exhaust side flow amount adjustment valve | |

Figure 1

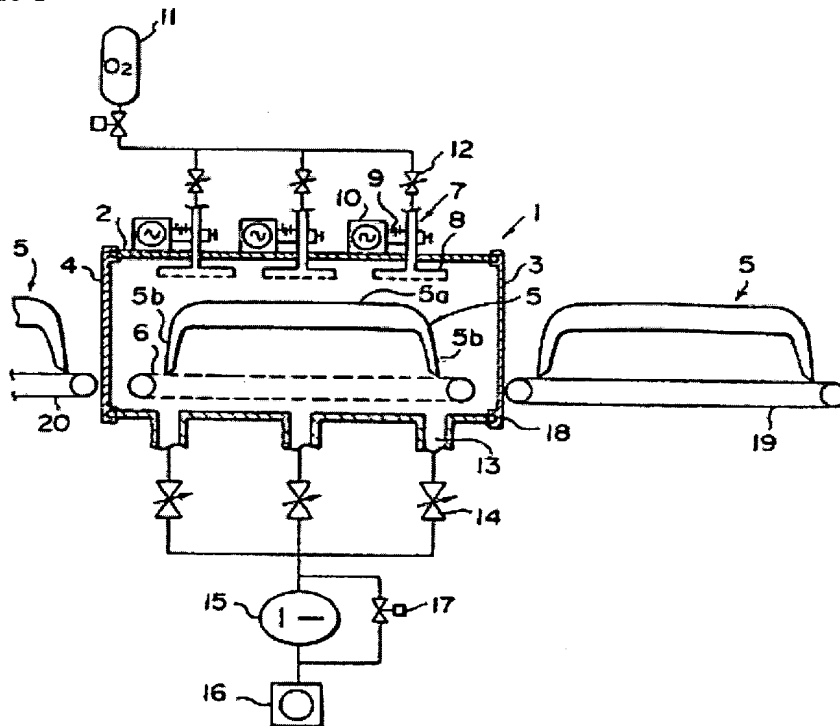
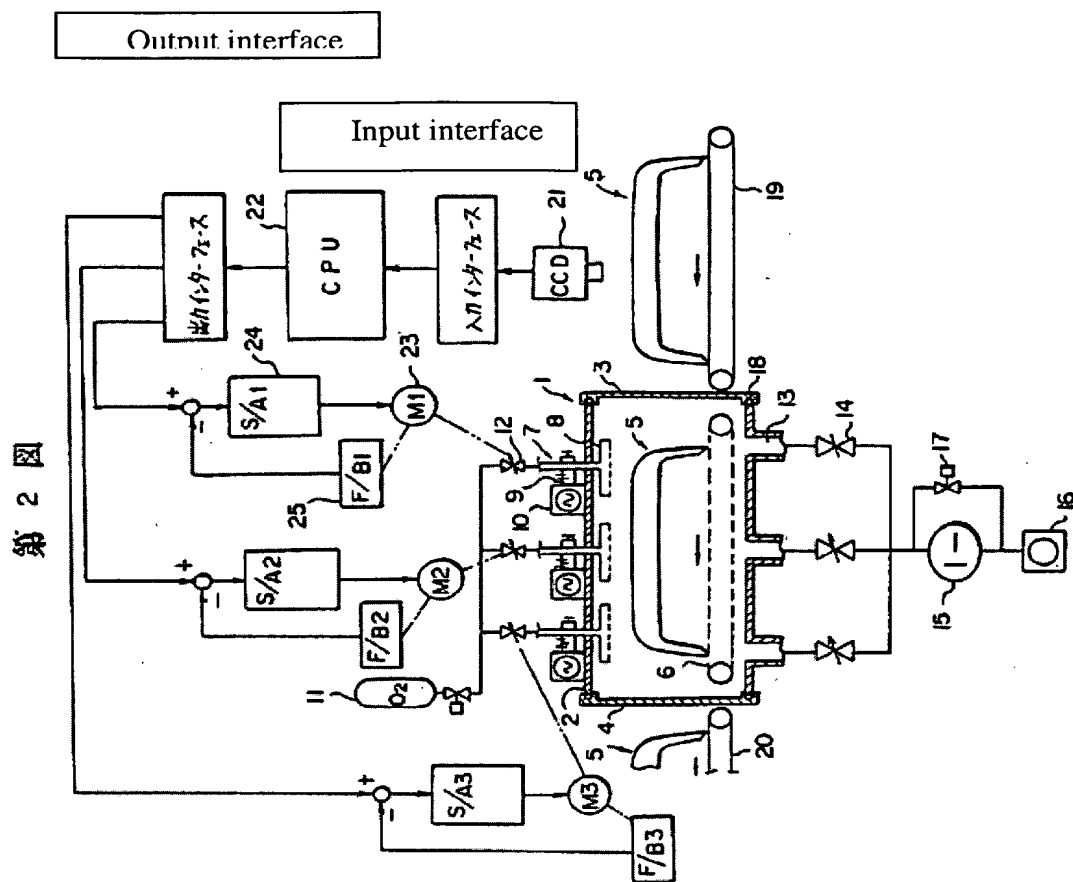


Figure 2



CPU
CCD

Figure3

Input interface

Output interface

